Ambient Monitoring Survey of the Virgin Islands Rum Industries, Ltd. Ocean Discharge

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Virgin Islands Rum Industries, Ltd. (VIRIL) is a rum manufacturing facility located in Fredericksted, St. Croix, U.S. Virgin Islands. The rum manufacturing process generates wastewater that is discharged to the ocean via a discharge pipe on the south coast of St. Croix. The pipe's outfall is located on the ocean bottom in Negro Bay, approximately 1,900 feet from the shore at a depth of approximately 18 feet. The effluent typically forms a visible plume that starts at the discharge point and travels 5.5 to 6 miles westward, following the shoreline, approximately 2,000 feet from shore. The plume disappears at a position south of the tip of Sandy Point located on the western edge of St. Croix, where the shallow shelf drops off to depths exceeding 600 feet.

VIRIL's process wastewater is composed of sugars, organic acids, amino acids, proteins, polysaccharides, and inorganic salt complexes, and has historically been characterized as having an extremely high BOD and COD, thus is very low in dissolved oxygen. Additionally, it has been shown to be toxic to mysids, with measured LC50 values of less than 10 percent effluent.

VIRIL's discharge is regulated by the Virgin Islands Government by means of a Territorial Pollutant Discharge Elimination System (TPDES) permit. The Caribbean Basin Economic Recovery Act (CBERA), passed by Congress in 1983, exempts this discharge from certain portions of the Clean Water Act (CWA). Specifically it exempts the facility from effluent limitations (Section 301), national standards (Section 306), and ocean discharge criteria (Section 403), as long as specified conditions are maintained. Among those conditions is the determination, by the Governor of the Virgin Islands, that the discharge will not interfere with attainment of water quality in the receiving water as specified in CBERA. To date, affirmative determinations have been made by the Virgin Islands Government, that the discharge is meeting this water quality condition.

The U.S. Environmental Protection Agency (EPA), in cooperation with the U.S. Virgin Islands Department of Planning and Natural Resources (DPNR), conducted an ocean monitoring survey in the coastal waters along the south shore of St. Croix, USVI. This survey, conducted in February 2002, was focused on the wastewater discharge from the VIRIL production facility. The survey was designed to characterize the receiving waters directly influenced by the discharge in order to assist the Virgin Islands Government in making determinations on the VIRIL discharge required by the CBERA exemption.

Aerial Photo of VIRIL Discharge

Underwater Views of Solids Plume

Monitoring Results

Field sampling and observations were performed to characterize water quality and biological conditions throughout the area observed to be influenced by the plume. A grid of sampling and observation stations was established in the receiving water area that is typically exposed to the discharge plume, and in two areas that represent background conditions outside the influence of the discharge. Water quality was profiled throughout the entire depth for light penetration, dissolved oxygen, pH, temperature, and salinity. Water samples were analyzed for biological oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), nutrients, and aquatic toxicity. Sea grass samples were also collected for biomass analysis.

The tables below present measurements of these analyses. Critical measurements are presented in red.

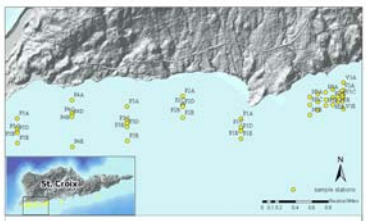

Figure A-1: Locations for Plume-Focused Hydrographic Profiling and Water Quality Samples

Summary of Receiving Water Acute and Chronic Toxicity Testing Statistically Significant Toxicity

Sample/ Station ID	Mysid-opsis bahia	Sur-vival (%)	Menidia beryllina	Sur-vival (%)	Arbacia punctulata	Sur-vival (%)
RA-2		92		90		85 or 87.4
Immediate vicinity						
V1	Significant	0	Significant	0	Significant	0
V2					Significant	0.4
Near field						
N1					Significant	73.4
N3					Not Significant	82.3
N5					Significant	74.2

Table 1 Summary of Oxygen Demand Analyses

	BOD (mg/L)	COD (mg/L)	TOC (mg/L)
Immediate Vicinity			
V1C	10.0	ND* (200)	ND (1.0)
V2CR	30.0	350	47.0
V3C**	27.0	390	61.0
Near Field			
N1C	4.3	ND (200)	1.1
N3C	6.9	690	3.6
N5C	4.3	ND (200)	ND (1.0)
Far Field			
F1C	3.4	280	ND (1.0)
F3C	3.8	430	ND (1.0)
F5C	4.8	280	ND (1.0)
Reference			
RA1C	ND (2.0)	ND (200)	ND (1.0)
RA2C	ND (2.0)	ND (200)	ND (1.0)

* - ND = not detected at the concentration in parenthesis
** - V3C is a QA duplicate sample of V2CR

Summary of Average Root and Leaf Dry Weights for Submerged Aquatic Vegetation Collected in the Vicinity of the VIRIL Outfall, February 2002

Station ID	Predominant Species	Average Leaf Wt. (g) Per Area	Average Root Wt (g) Per Area
Reference area			
RA1C	*Thalassia, Halimeda*	*.560*	***2.127***
RA2C	*Halimeda*	*.938*	***1.505***
Far field			
F5C	*Thalassia*	*.367*	***1.641***
F4C	*Thalassia, Halimeda*	*.435*	***1.023***
F2C	*Thalassia, Halimeda, Halophila*	*.201*	***1.177***
F1C	*Thalassia, Syringodium*	*.101*	***.565***
Near field			
N3C	*Thalassia, Halimeda, Penicillus, Syringodium, Udotea*	*.260*	***.798***

Legend of Sample/Station Prefixes:
RA - Reference Area
N - Near Field
F - Far Field

Light Attenuation Results

Ambient light in the receiving water was measured at 1-m depth intervals, and ambient light at the surface was measured simultaneously with each underwater light measurement. Calculations were performed, using the multiple depth light measurements and their corresponding surface light measurements, to determine the light attenuation coefficient (K) at each station along each transect of the study area. A regression formula for comparing data on attenuation coefficients and observed depth of colonization of *Thalassia testudinum* was developed in a 1991 compilation of sea grass research data from botanical literature (Duarte, 1991). This formula can be used to identify critical depths for colonization of the sea grasses based on available light.

Using this regression formula, a colonization depth (Zc) was calculated for each station. The colonization depth represents the depth at which SAV growth can be sustained. Depths below the colonization depth are considered to have insufficient light to support normal growth of the sea grasses. The data were plotted to determine estimates of depths at which sufficient light penetration would be available to sustain the submerged aquatic vegetation.

Water depths in the areas profiled for ambient light ranged from 4.5 to 5.4 m. Therefore sea grass beds colonization depths calculated to be less than these depths would indicate that there is insufficient light reaching the bottom to support normal sea grass growth. For this monitoring, Zc values calculated to be 4 m or less were identified as critical colonization depths. The *Summary of Critical Colonization Depths (Zc)* table presents a summary of the critical colonization depths estimated. A graphical presentation of the colonization depth estimated from these data is presented in The figure below.

Summary of Critical Colonization Depths (Z_c)

Reference Area				Immediate Vicinity					
Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)		
RA1A	13.90	RA2A	10.99	V1A	11.55	V2A	31.73		
RA1B	14.95	RA2B	10.14	V1B	3.76				
RA1C	20.52	RA2C	14.83	V1C	2.61	V2C	2.16		
RA1D	8.97	RA2D	9.01	V1D	4.37				
RA1E	26.47	RA2E	21.11	V1E	9.57	V2E	10.86		
Near Field									
Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)
N1A		N2A	16.30	N3A	23.23	N4A	4.96	N5A	5.61
N1C	6.09	N2C	3.69	N3C	2.45	N4C	2.93	N5C	2.22
N1E	10.16	N2E	5.81	N3E	25.70	N4E	9.27	N5E	7.29
Far Field									
Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)	Station	Z_c (m)
F1A	5.87	F2A	4.85	F3A	5.39	F4A	2.37	F5A	3.48
F1B	3.10	F2B	3.62	F3B	3.56	F4B	4.38	F5B	3.74
F1C	2.65	F2C	3.20	F3C	3.85	F4C	5.58	F5C	4.76
F1D	2.79	F2D	3.63	F3D	4.42	F4D	5.11	F5D	3.77
F1E	8.61	F2E	6.66	F3E	11.49	F4E	11.08	F5E	5.90

Conclusions

The 2-week effort to collect environmental data provided a snapshot characterization of physical, chemical, and biological conditions occurring in this coastal system at that time. The results indicate a potential for negative impacts to the coastal environment influenced by the VIRIL discharge. A summary of the significant conclusions follows.

Figure 6 - A thorough examination of water quality did not identify any significant water quality issues, including depletion of dissolved oxygen. However, although oxygen depletion was not detected in the condition of high mixing present during the survey, there is a potential for the high BOD of the effluent to cause a biologically adverse oxygen content in the receiving water during conditions of low mixing.

Figure 7 - There is significant acute and chronic toxicity in the receiving water due to discharge of the VIRIL waste.

Figure 8 - There is a strong turbidity and color attribute of the VIRIL discharge. This presents a potential for a critical adverse light-attenuating condition that could impede normal growth of submerged aquatic vegetation (SAV), such as turtle grass, in a significant area of the receiving water.

Figure 9 - There appears to be a diminished abundance of SAV within the influence of the plume, which yields a potential to alter critical benthic habitat for endangered species, and both commercially and biologically important species.

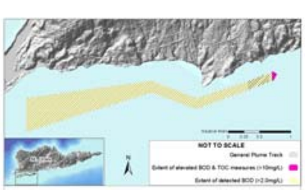

Figure 6: Water Quality Measurement

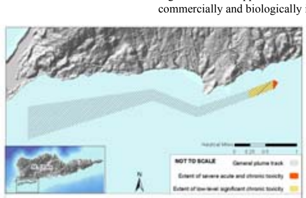

Figure 7: Potential Toxicity Impact Zone

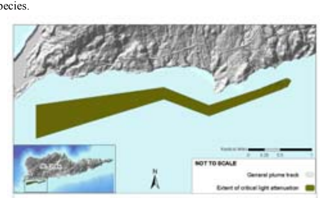

Figure 8: Potential Light Attenuation Impact Zone

Figure 9: Potential Subaquatic Vegetation (SAV) Impact Zone